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THE NEW YORK
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EDITORIAL

LAENNEC

The centenary of Laennec's birthday fell on February 17, 1881. In 1919, the centenary of his invention of the stethoscope and of the publication of his trea tise on medicate auscultation was celebrated with great eclat. He died one hundred years ago, on August 14, 1826.

He was a native of Quimper (Brittany), and came of an old Celtic family, the name of which ("Lennec") implies studious people (Thayer).[1] His mother died when he was five, and he was raised and educated by his uncle, an able physician of Nantes. From his father, a brilliant, vain, futile feather-witted man, Laennec acquired the remarkable versatility evinced in his talent for writing verses, flute-playing, dancing and athletics. He began to study medicine at Nantes in 1795. The year 1799 found him an army surgeon, first serving in the military hospital at Nantes, later participating in the Morbihan campaign. He resumed his studies in 1801, graduating from the Paris Faculty in 1804, with a dissertation on the Hippocratic writings. From his teachers, Corvisart (the translator of Auenbrugger), Bayle and Dupuytren, Laennec probably acquired his trend toward physical examination of the chest and pathological anatomy. As a student, he had already described for the first time, the pathological appearances of peritonitis (1802), the subdeltoid bursa (1803), the capsule of connective tissue investing the liver (1803)

[1] Thayer points out that the name is pronounced, and even spelled by Laennec's collateral descendants "Lennec" and not "Laënnec." The customary diaeresis was somewhat officiously added by one of his biographers, Theophile Ambroïse. See, Bull. Johns Hopkins Hosp., Balt., 1920, XXXI, 425–435.

and several new species of worms of the genus Cysticerus (1804). The memoir on peritonitis contains also the first notation of peritoneal tuberculosis. "For general peritonitis," as Thayer observes, "Laennec did that which, some 80 odd years later, Fitz did for appendicitis." His graduating dissertations, in Latin and French, are, however, slight, academic performances. The importance of the Hippocratic method is stressed, but Laennec doubts whether Hippocrates ever lived, suggesting the familiar couplet of Voltaire:

> "Pardonnez-moi, dit-il, en lui parlant tout bas,
> Mais je crois, entre nous, que vous n'existez pas."

In 1806, Laennec published the first accurate account of melanosis, although his inferences about its ultimate nature were faulty. In 1812, he described an extraperitoneal variety of hernia. Like most of the clinicians of his time, like Bright and the other pathologists before Virchow, Laennec was obviously the acute observer and delineator of what he actually saw, with no particular talent for generalization or effective (heuristic) reasoning. In spite of his physical fragility, his career during the Napoleonic period was one of incessant labor and feverish activity. During 1812–14, he served as assistant physician to the Hôpital Beaujon, during 1814–16 at the Salpêtrière, then a military hospital, where his proficiency in speaking the Celtic dialect was of inestimable aid to helpless Breton conscripts. In 1816, he was made chief of the medical service at the Hôpital Necker. Here, in the same year, he discovered his method of mediate auscultation and invented the stethoscope. In examining a fat woman afflicted with heart disease, Laennec found palpation and percussion impracticable, on account of the "age and sex of the patient," but he suddenly recalled seeing boys listening to the sound of a pin-scratch transmitted to the ear through a stick of wood. He thereupon rolled up a note book and got the heart sounds much more clearly and distinctly than by applying the ear to the precordial region. The first specimens of his invention consisted of three quires of paper, tightly rolled and glued together. He found that a solid cylinder is the best instrument for detecting heart sounds, and that a hollow cylinder intensifies the sound of the voice and of thoracic râles. He therefore devised the wooden stethoscope, which like the first clinical thermometers,

was about a foot long, and which he manufactured exclusively, at a turning lathe in his own room, for the benefit of students of his book. While Hippocrates, Bayle and others had occasionally listened at the chest, the application of auscultation by Laennec to diseases of the lungs and heart was virtually a discovery and of far greater moment than his invention, which he himself named the stethoscope. That this great discovery was the real beginning of physical or instrumental diagnosis is evident from the pages of Laennec's treatise on auscultation, the most important text-book on practice of medicine after Sydenham.[2]

The first edition of this book (1819) analyses the different signs and symptoms of diseases of the lungs and heart, with reference to diagnosis. As its title implies, it is really a treatise on auscultation. In the second edition (1823), there is a long preliminary section on examination of the chest, followed by a series of chapters on diseases of the bronchi, the lungs, the pleura, the heart and the cardiac blood-vessels, with treatment, as in a modern book on practice. This edition is, in effect, a synthetic treatise on diseases of the chest. Here we find absolutely new and withal masterly chapters on diagnosis and pathological appearances of bronchitis and pneumonia, with what are virtually the first accounts of pulmonary emphysema and oedema, pneumothorax, gangrene of the lungs, pulmonary apoplexy, haemorrhagic pleurisy, with such new diagnostic data as aegophony in pleurisy, pectoriloquy in phthisis, decrease of râles with percussion dulpleurisy and recognition of tubercles in the lungs as the pathological lesion in phthisis. The section on diseases of the heart in either edition of the book is not so good. In Laennec's time, little was known of the heart sounds, and he himself proceeded upon the erroneous notion that the second sound is due to auricular contraction. This phase of diagnosis had to wait upon the advent of Bouillaud, Corrigan, Skoda and the later clinicians. Meanwhile, Laennec's talent for observation was further demon-

[2] Laennec's treatise on auscultation passed through four Parisian editions, *viz.*, 1819, 1826, 1831, 1837, two Parisian reprints of 1879 and 1893, a Brussels reprint of 1828, English (London) translations of 1821, 1827, 1829, 1834, 1846, a Philadelphia reprint of the Forbes (London) translation (1823), New York reprints of 1831, 1835 and 1838 and a German version of the first edition (Weimar, 1822).

strated in such original clinical delineations as those of oesophagitis, chronic interstitial hepatitis and the "anatomic tubercle" (lupus verrucosus). At the same time, he contributed many articles on pathological anatomy to the A–F volumes of the *Dictionnaire des sciences médicales.* His method of case-taking at the Necker, and his way of correlating these clinical records with his post-mortem protocols, were of the approved modern type. Eventually these ardors of incessant work began to tell upon his health. He was of slight and fragile frame, and, in spite of his passionate addiction to hunting and athletics, already predestined to die, like Bichat, of phthisis. The infection was probably acquired from an accidental wound of the finger during an autopsy, developing the anatomical tubercle mentioned above. In 1820, worn out with hard work and asthma (incipient phthisis), he found himself obliged to retire to his estate at Kerlouarnec. Here the sea-air eventually restored him to apparent health. After spending two years in this retreat, he could not resist the call to Paris. Laennec returned to the capital in 1822, and shortly thereafter became physician to the Duchesse de Berri and professor of medicine in the Collège de France. He soon acquired a large practice, engaged in a half-humorous warfare with Broussais, whom he slyly likened to Paracelsus, and, in 1824, married his housekeeper. The revision of his book occupied the next two years, but the stress and strain of this work again broke down his health and upon its completion, he again retired to Kerlouarnec in June 1826, to die there on August 15, at the age of 45. A statue by Duquesne was erected to his memory at Quimper in 1868. There is also a bust by Toulmouche and an excellent portrait by Dubois at Nantes, painted in 1812, when Laennec was about thirty years old.[3] It represents a man of delicate features, oval face, of whimsical expression, with curly hair and the long upper lip of the Celt. The handsome lithograph executed by Formentin, apparently from a photograph, is the most satisfactory likeness.

[3] Copies of these pictures, with cuts showing the manor at Kerlouarnec, the statue at Quimper, etc., may be seen in the volume of selections from Laennec by Sir William Hale-White, in "Medical Classics Series," London, John Bale, 1923.

Dr. Goodrich (Peter Parley) describes a visit to Laennec's clinic at the Charité as follows:

"He is a little man, 5 ft. 3 in. high and thin as a shadow. However, he has acute features and a manner which bespeaks energy and consciousness of power. The whole hospital was neat and clean; bedsteads of iron; French medical practice very light; few medicines given; nursing is a great part of the treatment. Laennec's pupils followed him from patient to patient. He conversed with them in Latin."

Sainte Beuve, a contemporary and himself a student of medicine, already refers to Laennec in *Portraits contemporaines*, as a "great physician," and gives a very pleasing picture of his familiarity, as a flute-player, with the Celtic airs of Brittany.

Our present feeling about Laennec is expressed in the Hippocratic sentence cited by Thayer, which forms the motto of the treatise on auscultation.

"The power to explore is to my mind a great part of the art."

Laennec stands for the kind of physical diagnosis which will never be displaced in medical practice, the kind the Victorian physicians followed, and which can only be really understood and appreciated by collateral studies in the dissecting room or dead house. The many and sometimes elaborate instruments of precision and diagnostic tests now in use have gone far to destroy this power to diagnose without instruments in both student and practitioner of to-day. Thayer instances cases of X-ray appearances mistaken for phthisis, of ulcerative endocarditis treated as typhoid fever, of pleural effusion regarded as unresolved pneumonia, "one hundred years after the publication of Laennec's book." Reliance upon the electrocardiograph is all too common. The fault, as Thayer insists, lies not with the student but in the way in which he has been taught. "Proficiency in the basic methods of exploration, which we owe to Auenbrugger and to Laennec, is as vital to-day as it was one hundred years ago."

F. H. Garrison

THE NEW YORK ACADEMY OF MEDICINE—ITS OBJECTS, FUTURE DEVELOPMENT AND FINANCIAL NEEDS

Foreword

Early in May, the President called together a group of Fellows of the Academy at an informal dinner at which were discussed the needs of the Academy and in particular the library. After a presentation of the facts which are given in the following article it was suggested to the President that a special meeting of the Council be called to discuss in general the needs of the Academy. At this special meeting of the Council held on May 7, the President was authorized to appoint a special committee on increased endowment.

It was agreed that there should be no drive, but that when opportunity offered the members of this special committee should present the needs of the Academy to such individuals as they might deem proper with the hope of securing donations.

The following suggestions were made to the Committee: that the Committee endeavor to interest the Fellows of the Academy in making a personal bequest to the Academy and also to suggest to others the possibility of mentioning the Academy in their wills and that this might also be suggested to lawyers who were frequently called upon to name institutions to which a legacy might properly be given.

The Committee was also asked to consider the possibility of Fellows of the Academy insuring their lives for restricted sums in favor of the Academy.

At the meetings of nearly all the Sections during the winter, the attention of the Fellows has been called to the fact that the dues of the Fellows would have to be increased in order to meet the increased expenses in the new building. If the proposed new activities are to be satisfactorily carried out and the library properly maintained and developed, a million dollars new endowment will only be sufficient to meet the initial needs.

The Council hopes that the Fellows of the Academy will bear these conditions in mind and lend their support to the Academy's activities and aid in such manner as may seem to them advisable and proper.

The New York Academy of Medicine is a membership corporation founded in 1843 and incorporated by the Legislature in 1847. It consists of 1625 physicians who are resident Fellows, 92 non-resident Fellows and 20 scientists who are Associate Fellows, a total membership of 1737.

Object

The Academy is organized for the promotion of the science and art of medicine, the maintenance of a public medical library, the promotion of the public health, and of medical education.

These activities are under the direction of a Council consisting of the elected officers, the chairman of the standing committees and ten elected Trustees.

The Promotion of the Science and Art of Medicine

The Fellows are grouped into thirteen different sections, each one of which represents some special branch of medicine or surgery. These sections hold monthly scientific meetings and there are one hundred and four held annually. In addition, there are sixteen meetings of the Academy. All of these meetings are professional in character at which papers are read on medical subjects, patients are presented and discussed, instruments are shown, specimens removed at operation and autopsy are exhibited and physicians who are not Fellows, from the city and elsewhere, are invited to lecture on new discoveries in medicine. Physicians and dentists who are not Fellows, and medical students frequently attend these meetings and are always welcome.

In addition to the regular meetings of the members of the Academy, 38 medical societies hold their regular meetings in the building. These meetings are also educational in character and are attended by the members of these societies.

The Library

The library of the Academy is the second largest medical library in the United States. It contains 140,000 bound volumes, 104,500 pamphlets, 1,970 medical classics and rare medical books and 43 incunabula or books printed prior to 1500. It also possesses a considerable number of portraits and engravings of medical men, hospitals and medical activities. The card catalogue is readily accessible and is simply arranged for the convenience of

the readers. In the main reading room are found the index catalogues and reference books and bound volumes of journals of the past eight or ten years.

The library staff aid the Fellows and the public in answering inquiries, assisting them in securing needed information and furnishing books to the readers in a very short space of time.

The library is used by 30,000 readers a year, among whom are not only physicians but also public health officials, medical students, representatives of publishing houses and also newspaper men and dramatic writers seeking technical information. (For further information see reprint from the June 1926 Bulletin entitled "Needs of the Library," by Archibald Malloch, M.D., Librarian.)

The Promotion of the Public Health

The Public Health Committee was organized in 1911. It studies various phases of community health, quarantine, communicable diseases, hospitals, dispensaries, day nurseries, convalescent homes, and various other community health activities. The committee advises various city departments and private agencies and makes studies for them which frequently result in improvements of method or operation. The efforts of the members of the committee were largely instrumental in bringing about the transfer of quarantine from New York State to the Federal Government and its advice has been accepted resulting in the abolition of dispensaries, the consolidation of hospitals, and the development of a proper program for the care of different types of disease.

The Promotion of Medical Education

The Committee on Medical Education was organized in 1924. It has made a survey of courses and other opportunities for graduate medical study in New York with a view to improving the value of existing opportunities and encouraging the development of additional ones. A series of synopses describing approved courses and internships has been published by subjects and has been widely distributed. The committee maintains a bureau of clinical information which provides a central meeting place or headquarters where visiting medical men may obtain information regarding all medical activities in the city. It has

collected and classified detailed information regarding opportunities for graduate medical study in other cities of the United States, Canada and Europe and is prepared to advise physicians who desire information regarding such opportunities offered in any medical center. The bureau publishes a daily bulletin of surgical operations and a weekly bulletin of medical clinics given in the important hospitals of the city.

Admission to Fellowship

A physician is admitted as a Fellow on account of his professional attainments. He must show evidence of a skill in practice or if not a practitioner, he must hold some responsible position in a hospital, laboratory, or medical school. Further, he must have lived up to the ethical standards of the profession. The Academy is in no sense a club and there are no social activities. The only possible semblance of a social activity is the furnishing of light suppers after stated meetings of the Academy which are provided by the income of an endowment bequeathed for this special purpose by Dr. Alfred L. Loomis.

New Program and Building

The present quarters of the Academy became entirely too small for its activities as far back as 1910 when a proposal to enlarge the present building at 43rd Street or to secure a new building was first broached. After repeated discussion and postponement due to war, increased prices, and other reasons, a definite plan was agreed upon in 1922 which culminated in a gift of $1,550,000, from the Carnegie Corporation for a new building and a pledge of $1,250,000 for the endowment of new educational activities from the Rockefeller Foundation.

The Rockefeller Endowment

The Rockefeller Endowment will provide approximately $62,500 a year and its use is limited for the salaries of a director, a librarian, and educational activities and is to be employed for the purpose of making studies and surveys of community health problems, for the promotion of post graduate medical education, for the maintenance of a bureau of clinical information and the enlargement of library activities. Those restrictions apply until 1933 but there are none thereafter. This fund cannot be used

for the maintenance of the building nor for the purchase or binding of books, journals and pamphlets, but is strictly limited to new educational activities, most of which have already been undertaken.

New Building

The new building situated at the south east corner of 103rd Street and Fifth Avenue on a lot 100 x 175 feet is rapidly approaching completion. The building will contain a large auditorium and five large meeting rooms. There are commodious reading rooms for the library and a stack which will hold 250,000 volumes and which is capable of being enlarged. It also will provide for the Academy's administrative offices and committees and also the offices of the Medical Society of the State of New York, the Medical Society of the County of New York, the First District Dental Society, the Society for the Relief of Widows and Orphans and the New York Physicians Mutual Aid Association and nearly all of the thirty-eight special medical societies and others will hold their meetings in it.

New Activities

Committee on Medical Education

The continued promotion of postgraduate medical education will demand an additional staff to make the necessary studies under contemplation. Studies should be made of sickness and its causes, the results obtained in various hospitals, the different methods employed in these hospitals and a comparison of the results, the creation of new teaching courses in special hospitals not now utilized for this purpose, cooperation with various medical schools in the development of postgraduate teaching and other opportunities which are being considered for improving the possibilities of medical practice.

Lectures

Under the auspices of the Committee on Medical Education it is proposed to give a series of lectures annually on clinical subjects for the members of the medical profession and also to provide popular lectures for the community on medical subjects. It

is also proposed to keep the public informed on questions relating to disease and its cure.

The Committee on Public Health Relations

This committee will continue its studies and will, it is hoped, take a more active part in cooperating with the various city departments that have to do with the prevention of sickness, care of patients, the safe-guarding of the city's food and water supplies and the disposal of the city's wastes. To carry out these plans, the Public Health Relations Committee will need additional funds.

Library

The Academy has agreed that the library should be further developed. The new building will permit the reading rooms to be open to the public until five in the afternoon. Additional periodicals in Spanish and Italian should be obtained as well as chemical journals. A book delivery service should be developed. Bibliographers should be employed to aid in the preparation of scientific articles. A photostat should be installed for making photostats of rare pamphlets, books or illustrations. Exhibitions of medical works, medals, instruments, etc., should be given from time to time. Brooklyn has its own medical library but serious consideration should be given to providing reading rooms for physicians in the Boroughs of Bronx and Queens. The collection of incunabula and medical classics should be enlarged.

A medical library differs from a general library only in that its work is limited to a special field. The library will need an increased endowment for the purchase of books, pamphlets, periodicals, classical books, incunabula, portraits, engravings of medical celebrities, etc. The Academy has received twenty special bequests for the library. Nineteen of these are restricted to the purchase of books. The income of one only may be used for the maintenance of the library. These sums, however, are small and the total income amounts to $15,000.

Finances of the Academy

The Academy owns the new site and will own the new building free and clear of mortgage. The present annual expenses of the Academy are $171,000. Its present income is as follows:

From permanent endowment	$45,000
From Rockefeller Foundation	53,000
From assessment for the use of rooms	12,000
From dues of Fellows	33,000
From Witthaus estate	6,000
From miscellaneous income	13,750
Total	$162,750

For 1926 only, there is an available balance of $8,250 for special purposes.

The annual expenses of the Academy in the new building will be $225,000. The income of the Academy will be increased by the proceeds of the sale of the present premises after the payment of a mortgage and the equipment of the new building, by $22,250, which will bring the total income up to $185,000. The proper maintenance of the Academy and its activities requires an increased income of at least $40,000 annually.

Specific Needs

The Academy needs an additional endowment

For the Committee on Medical Education of	$100,000
For the Committee on Public Health Relations of	250,000
For the adequate maintenance of the library of	600,000
For lectureships of	50,000
	$1,000,000

INCREASED ENDOWMENT NEEDED

Many of the Fellows will recall that the two underlying reasons for abandoning the 60th Street site were the high cost of the land and the very large increased cost of maintenance when the new building would be finished. The sale of the 60th Street property and the final decision to build at 103rd Street has increased the Academy's endowment by about $700,000.

In Bulletin Volume II, No. 2, published in February, 1926, there was a statement signed by the Treasurer showing the status of the Academy's finances and the need for increased funds.

At a meeting of the Council held in May the President was authorized to appoint an Endowment Committee for the purpose of securing additional funds for the Academy. The following Committee was therefore appointed: Dr. Brown, Chairman, Drs.

Stewart, James, Pool, Lyle, Patterson, Sachs, Bullowa, Sondern, Haynes, Libman, Malloch, McKernon, Foster, Lusk, van Beuren, Kast, Starr, Morris, Stillman, Dana, Miller, St. John, Wallace, Milliken, Beekman, Elsberg, Carter, Delavan, Duel, Moorhead, Cecil, Senior, Blodgett, Hunt, Hartwell and Williams.

At meetings held by this Committee it was agreed that there should be no drive but that every effort should be made by the Committee to secure funds for endowment and it was also agreed that the Committee should endeavor to persuade as many of the Fellows as possible to mention the Academy in their wills in such amount as they feel it possible to bequeath to the Academy.

The Endowment Committee agreed that an additional million dollars should be secured and agreed with the Council that it would be necessary to increase the dues in 1927. The Committee is happy to report that it has received a pledge of $10,000 a year for five years beginning January first and an unconditional gift of $36,000.

A statement was prepared by the Librarian, Dr. Archibald Malloch, outlining the special needs of the Library. Reprints of this article have been made and copies will be sent to any of the Fellows upon request.

The Council has realized for over a year that the dues of the Fellows would have to be increased and during the winter they instructed the Director to speak before as many of the Sections as possible on the necessity of increasing the dues next year. In the year 1927, the Academy will need an additional income of $55,000 and this sum must be raised either by increased endowment or dues. The increase of the dues has been discussed on a number of occasions and it has been agreed by the Council to postpone any definite recommendation until November, as the amount of the increase will depend upon the success of the Endowment Committee. The Council desires to bring to the particular attention of the Fellows the fact that dues have not been increased since 1890, when they were raised from $10 to $20, and that at the present time the income from dues is approximately $32,000 and that in the present building these dues just pay for the heating, lighting and maintenance of the building, and that no part of the dues is used for the Library, the Committee on Public Health Relations, the Committee on Medical Education

or for salaries of the administrative personnel. It is estimated that the new building will cost at least $65,000 a year for maintenance and it is hoped that the Fellows will appreciate the necessity of meeting most of the expense of maintenance from dues.

CARBON MONOXID POISONING AND THE AUTOMOBILE EXHAUST

Review of Literature

by

The Special Sub-Committee of the Committee on Public Health Relations

Introduction

Carbon monoxid poisoning is closely related to the history of mankind. This dangerous gas was produced when fires were first kindled and is encountered whenever organic matter is burned. The effects of carbon monoxid were known in antiquity. Lewin in his exhaustive monograph on the history of carbon monoxid poisoning gives numerous quotations from the ancient writers. Aristotle, nearly 300 years B. C., observed that "men suffer from heaviness of the head and often die from coal gas."

The many cases of carbon monoxid poisoning described in the literature of antiquity clearly indicate that this poison has been, since early time, a frequent cause of death by accident or by suicide and has even served as an instrument of punishment and torture.

Julian the Apostate (331–363 A. D.) tells how during a severe winter in Lutetia, now Paris, he had a small fire brought into his room which "affected his head and put him to sleep; he being carried out unconscious."

Plutarch claims that Catulus, after Marius decreed he should die, shut himself in a room and "suffocated himself with the vapor from many glowing coals." In 68 A. D. Seneca after a number of attempts at suicide finally "ended his life by breathing the vapor of burning charcoal."

Carbon monoxid as a means of punishment is frequently recorded in ancient literature. Hannibal (247–183 B. C.) put the

inhabitants of Nuceria to death by "coal vapor." Many of the martyrs met death from carbon monoxid fumes in smoke.

Carbon monoxid is undoubtedly one of the most widespread and important poisons associated with human life and industry. Whenever any organic substance is oxidized, carbon monoxid is one of the products of the combustion. It has been shown by many writers that there is scarcely a single industrial activity in which carbon monoxid is not encountered.

At the First International Congress of Labor, held in Washington in the fall of 1919, the delegates were instructed to call the attention of their respective governments to the steady increase in industrial carbon monoxid poisoning and to request that investigations be made with a view to its prevention. The very marked increase in recent years in the number of such cases has been largely due, it is believed, to the extended use of illuminating gas as a source of heat and power and to the rapidly increasing use of the internal combustion engine whose exhaust contains more or less carbon monoxid.

One reason why in the past the public has not been more cognizant of the dangers of carbon monoxid as compared to some other industrial poisons is that the gas is colorless, tasteless, and practically odorless and does not, like chlorine or a number of other gases, produce immediately such irritating effects, when breathed in low concentrations. If the amount of carbon monoxid present in the air being breathed is small, the victim commonly has no warning that he is being exposed to a dangerous poison until the gas has so far affected him that he is powerless to aid himself.

A question of very considerable importance in any study of carbon monoxid poisoning is that of the rapidity with which the gas is given off after it has once combined with the hemoglobin of the blood. Glaister (Gas Poisoning, p. 324) states it is a combination most difficult to disturb. Apfelbach (Kober & Hanson, Diseases of Occupation, p. 46–47) calls attention to the fact that the affinity of the hemoglobin for carbon monoxid is 300 times greater than its affinity for oxygen and that CO unites rapidly with the hemoglobin, replacing the oxygen and forming a very stable compound, which is probably never dissociated until the blood corpuscle meets its death and is eliminated.

On the other hand, Hamilton maintains that in spite of the avidity with which CO is taken up by hemoglobin, the resulting combination is unstable and the red cells readily surrender the CO when pure air is breathed. Nicloux (Compt. rend. de la Soc. de Biol. 1901, 53, 120) finds that blood corpuscles are not devitalized even though they have been fully saturated with carbon monoxid and will perform their normal function when supplied with oxygen. Michel (Ueber die Dauer der Nachweisbarkeit von Kohlenoxyd im Blute und in Blutextravasaten uberlebender Individuen. Vierteljahrschr. f. Gerichtl. Med., 1897. Vol. 14, p. 36) says that though the combination of CO with hemoglobin is more stable than the oxygen combination, the former is disestablished or disunited not merely by the mechanical but also by the vital processes of the circulation. He believes that in general the CO is thrown off in a quarter of an hour in pure air. He is also of the opinion that the period of time during which the presence of carbon monoxid may be detected in the blood does not depend alone upon the duration of the period of exposure or its intensity, but upon individual peculiarities as well. In most cases, however, the length of time during which CO may be detected depends largely upon the period of exposure.

The combining power of carbon monoxid and hemoglobin is about 300 times that of oxygen and hemoglobin. It might be expected that carbon monoxid would show its greatest avidity for oxygen-free hemoglobin, but Hill and Barcroft (Bio-Chem. Jour. 1913, V. 7, 471, ibid. 481) have shown that carbon monoxid enters into combination more readily when a little oxygen is present than when it is completely absent; in other words more CO will be taken up by unsaturated oxyhemoglobin than by oxygen-free hemoglobin.

Hayhurst (Problems of Carbon Monoxide and Automobile Exhaust Gases) has pointed out that although the blood in the general circulation may contain a very high percentage of carbon monoxid there may be practically none in the spleen, but that when the CO eventually reaches the spleen it is retained much longer than in the general circulation. Barcroft (quoted by Hayhurst) states that from animal experimentation it has been found that unless the CO reaches more than 20 per cent. saturation in the resting animal the gas does not penetrate the spleen

pulp, which will remain entirely free from the gas for as long as four hours. In active animals the CO hemoglobin penetrates at once into the spleen pulp so as to be noticeable within five minutes.

While it is known that this gas is responsible for many thousands of deaths in the United States each year, it is not known how many cases of so-called "severe" carbon monoxid gassing occur without immediate fatal termination. A considerable portion of the writings on carbon monoxid poisoning are by industrial hygienists who devote their attention largely to the cases that have been more or less severely gassed and are in need of medical attention. As a result, the literature on the subject contains relatively few studies on the loss in industrial efficiency to those who are frequently exposed to low and well diffused concentrations of carbon monoxid; and even less attention has been given to the possible menace of carbon monoxid to every man who lives or works in our crowded cities.

Each year a considerable number of deaths of an accidental character is due to the carbon monoxid in the exhaust of automobiles. These deaths occur principally in the winter in private garages as a result of starting and "warming up" an automobile in a closed or confined space. When the engine is run "idled" to warm it in cold days with the garage doors closed, the atmosphere of a space amply large enough to hold a car is contaminated to a very dangerous extent (25 parts of carbon monoxid in 10,000 of air) within five minutes, and within ten minutes the concentration of the gas reaches a point rapidly fatal to life.

At present, practically all internal combustion engines depend for their motive power upon the explosive nature of a mixture of air and a petroleum distillate, generally "gasoline."

There are two distinct groups of opinion concerning the cumulative effects of breathing carbon monoxid in small concentrations. The one of which Haldane is the chief exponent maintains the view that all symptoms of carbon monoxid poisoning, primary and secondary, are attributable solely to lack of oxygen, while the other group ascribes the symptoms to the specific toxic effect of the carbon monoxid itself.

I

Anoxemia

Dr. Alice Hamilton, in her recent book "Industrial Poisons in the United States" (Macmillan, 1925, p. 371 et sequa), has very clearly stated the case as viewed by Haldane and others.

The effect produced by carbon monoxid, according to this school, can be traced to the lack of oxygen and the symptoms are those of anoxemia. Haggard (Studies in Carbon Monoxid Asphyxia; I. The Behavior of the Heart, Am. J. Physiol., 1921, 56, 390–403) maintains that there is no direct toxic action of carbon monoxid on the heart; for if respiratory failure is prevented by means of administration of 8 to 10 per cent. carbon dioxid, the CO combination with the hemoglobin may rise to an unusually high percentage without any evidence of impairment of the heart function. Death in cases of carbon monoxid asphyxia is due to the failure of respiration of the nature of a fatal apnea vera. Haggard further states that the lack of oxygen resulting from the formation of CO hemoglobin induces excessive breathing which in turn results in an abnormal loss of carbon dioxid followed by failure of respiration. The increasing anoxemia from this cause speedily results in the development of heart block through its various stages.

During the period of carbon monoxid asphyxia, injury to certain tissues may occur because of the temporary deprivation of oxygen. Those cells whose need of oxygen is greatest suffer the most severe injuries. This, however, is not, strictly speaking, a toxic action since, as Henderson (J. A. M. A. 1916, 67, 580) says, "It is not retention of carbon monoxid nor any direct action of the gas, but the result of the injury to the brain and other organs due to insufficient oxygen supplied by the blood while the patient was breathing the gas, which is responsible for the prolonged coma and subsequent death or incomplete recovery."

Haldane, in support of his view that all the symptoms of carbon monoxid poisoning are referable simply to want of oxygen, cites the fact that if animals are placed in oxygen under a pressure of from one to two atmospheres and carbon monoxid forced in on top of the oxygen, these animals continue to live notwithstanding the fact that the blood and tissues are saturated with

the CO gas. "But it has been pointed out (Glaister and Logan, Gas Poisoning, p. 351) that such animals receive from the high pressure oxygen enough of the gas in simple solution in the arterial blood to supply the tissues, in spite of the presence of the carbon monoxid."

The cause of the lesions in the central nervous system frequently found after death from carbon monoxid poisoning has been the source of much divided opinion. According to Dr. Hamilton (Industrial Poisoning in the United States, p. 374), the earlier investigators attributed them to a primary toxic action of the CO on the central nervous system, while others, especially the more modern pathologists, maintain that the changes are due to oxygen deprivation.

Balthazard (Les Idées actuelles sur l'Intoxication oxycarbonée, Bull. de l'Acad. de Med. 1919, 41, 439) opposes the view that carbon monoxid has a direct toxic action on the nervous system, holding that the degenerative changes reported are antifacts and that all the manifestations following CO gassing may be explained as the result of oxygen starvation. It is felt by many that this view is supported by the work of Haggard (Studies in Carbon Monoxid Asphyxia; II. The Growth of Neuroblast in the Presence of Carbon Monoxid. Amer. Jour. Physiol., 1922, V. 60, p. 244–249), who showed, by growing neuroblasts in vitro, that carbon monoxid itself even in a concentration of nearly 80 per cent. exerted no injurious effects upon the growing nerve cells. In this respect, it is as inert as nitrogen. Illuminating gas on the other hand was found to be poisonous to neuroblast culture even when present in concentration as low as 0.1 per cent.

II

Specific Toxicity

The members of the other school of opinion believe that the deadly effects of carbon monoxid are largely due to a specific toxicity of the gas. Linossier (Contribution à l'Etude de l'Intoxication Oxycarbonée. Lyon Méd., 1889, No. 28, p. 357) has shown that snails whose blood does not contain hemoglobin, when placed in an atmosphere of carbon monoxid and oxygen die more quickly than is the case when they are placed in an atmosphere

of hydrogen or nitrogen and the same proportion of oxygen as in the former case. Linossier has also shown that animals die more rapidly when exposed to carbon monoxid than when simple asphyxia is induced by placing them in an atmosphere of physiologically inert nitrogen. Lamie (Contribution à l'Etude de l'Intoxication Oxycarbonée. Bordeaux, 1891, 75 p. No. 20) working along similar lines has pointed out that frogs are capable of living three and a half hours in nitrogen, but only for one and a half hours in carbon monoxid.

The opponents of the anoxemia theory of Haldane declare that if this theory explained all the conditions, the use of oxygen gas should in the case of survivors of exposure to carbon monoxid prove more frequently successful in restoration than is generally experienced. Of course, it may be explained that owing to the action of the gas, the brain, heart and lungs have been so crippled by want of oxygen, as not to be able to make use of oxygen when artifically supplied.

Geppert (Kohlenoxydvergiftung und Erstickung. Deutsche Med. Woch., 1892, 12th May, p. 418) concludes as a result of experimental research that carbon monoxid exerts a specific action on the nervous system since the type of respiration which follows the inhalation of CO gas differs materially from that observed in oxygen-starvation with slow asphyxiation. Glaister (Glaister & Logan Gas Poisoning, p. 353–4) believes that as the respiratory centers do not respond to the lack of oxygen by an increase in respiration, it is a legitimate inference that CO has a particular specific action on the nerve centers and nerve tissues.

Apfelbach (Kober & Hanson, Diseases of Occupation, p. 47) has pointed out that the sequelae, particularly those of the nervous system, which frequently follow CO poisoning even with small doses, are accompanied by definite pathologic changes which indicate the toxicity of carbon monoxid. Moreover, the gas is rapidly narcotizing, and the earliest symptoms, such as weakness in the lower limbs, are strongly suggestive of some distinct toxic action.

Hayhurst in discussing the question of whether asphyxia explains all the phenomena of CO poisoning has pertinently asked, "How do we explain the fact that in acute cases of poisoning such as occur after a few minutes of exposure in a closed garage,

nervous symptoms such as weakness of the knees, faintness and loss of consciousness *invariably* occur before warning respiratory symptoms such as shortness of breath, rapid breathing, cyanosis and such phenomena usually associated with asphyxia or air hunger?"

The discovery by Claude Bernard that in carbon monoxid poisoning the oxygen was expelled from the blood by the former gas led to the theory that CO acts by producing asphyxiation but the question as to whether the CO itself had any specific action was not raised at that time. It was known that in CO poisoning there was no dyspnoea as in ordinary anoxemic asphyxiation. In the latter case the system endeavors to obtain more oxygen by rapid and forced respiration and increased pulmonary action.

"It would appear that a reasonable explanation of the action of the gas upon the body organism is that negatively the organism suffers from the relative anoxaemia which is consequent upon the excess presence of CO in the air, but it also suffers positively from the action of this upon the blood and through the blood upon the central nervous system." (Glaister and Logan, Gas Poisoning, p. 352.)

Regardless of what may be the belief as to the nature of CO poisoning, whether CO causes only a simple asphyxia or is a toxic agent, it is well recognized that where carbon monoxid has been inhaled for a considerable time the damage done to the nervous tissue, especially the vital nerve centers, is very serious. Some observers declare that carbon monoxid exercises a specific action upon the central nervous system through the circulating blood. Carbon monoxid apparently exerts a specific action upon the nervous mechanism of the heart which has been attributed to its specificity for the nerve centers.

III

Clinical Symptoms

Carbon monoxid poisoning is commonly referred to as being either of an acute or chronic character.

A. *Acute*

The onset of symptoms in acute poisoning may be as sudden as a stroke of lightning, and this is frequently the case among workers at blast furnaces and in coal mines.

The suddenness of death in mine accidents is clearly shown by finding the dead men with their lunches in their hands, or still holding their miners' picks as in the act of using them again. Usually however, even in exposure to a high percentage of the gas, the man has some warning that an attack of the gas is threatening. In contrast to cases with sudden fatal onset, gassing may occur in so mild a manner as to produce only a headache.

In some cases a relatively high percentage of carbon monoxid may cause premonitory symptoms such as pressure and throbbing in the head, a feeling of the legs giving way under one, blurring of the sight, or roaring in the ears. In some cases, a sweetish taste or feeling of dryness and constriction in the throat, or nausea or a pain in the stomach has been noted. Glaister reports that many coal miners have told him of a feeling of weakness in the legs that warned them of the presence of the dangerous monoxid, but that the gas had already so dulled their minds that they kept on working in a mechanical way until they fainted.

Sir D. LeNevell Foster in his now classic description of his experience when overcome by carbon monoxid while performing rescue service at the time of the great Snaefell mine disaster, stated: "I suddenly felt decidedly queer; I took out my little brandy flask, but already my fingers seemed incapable of opening it. Everything seemed to be in a whirl, there seemed to be dense white fog. We all sat still without trying to escape. The foot of the ladder was quite near but none of us made an effort to reach it."

When he found himself being overcome he took out his note book to write a farewell letter to his wife and children. In this letter (Glaister & Logan, Gas Poisoning, p. 126) he repeats many words again and again and sometimes whole sentences. Later he remarks, "I had absorbed enough of the poison to paralyze me to a certain extent, but at the same time my reason had not left me. The general sensation was like a bad dream, and yet I was able to reason and write intelligently, though in a disjointed fashion." When he was rescued and brought to the surface he had a feeling of exhilaration and was in full possession of his senses. A few hours later he felt very sick and afterwards became unconscious and had an epileptiform seizure.

According to Haldane, when the amount of carbon monoxid is not more than ten parts in ten thousand the blood of a man breathing it may progressively take up carbon monoxid till fully 50 per cent. of the hemoglobin has become saturated with it. At that point the man suffers from its effects so that he becomes confused, his intellect is dulled, and there is muscular weakness. If he remains at rest, he may escape serious consequences even at this concentration, but if he makes any considerable exertion to escape from such an atmosphere, he may lose consciousness. Such a person would be said to have experienced a case of acute carbon monoxid poisoning.

One of the physicians of the United States Steel Company, who in his seventeen years of experience has seen hundreds of cases of CO gassing, states that he has observed that in cases of sudden gassing at the steel mills, if the man is not killed outright he always recovers and needs no treatment other than to be removed from the gas filled atmosphere. The severe cases are brought to the hospital usually within twenty minutes after the accident unconscious, with stertorous respiration, rapid and deep, face not cyanosed or only slightly so, with pulse 80 to 120 but neither weak nor bounding. In some cases the man passes from unconsciousness into violent maniacal delirium, in which he struggles and seems to have hallucinations. This stage lasts from fifteen minutes to an hour. It is accompanied by vomiting and lack of control of the bowel movements. Normally sleep follows, although at times it must be induced. After two to eight hours, the man awakens with a severe headache which persists several hours but with no other symptoms. Then for about a day he complains of weakness and general lassitude, but after that he returns to work. Even the worst cases of sudden CO gassing are out only 72 hours.

B. *After Effects*

Glaister maintains that the course of the poisoning determines the after effects. Slow, gradual gassing produces much more severe and permanent damage than does a rapid poisoning even though the latter may result in coma, convulsions and delirium.

Practically every man who recovers from a severe gassing suffers a headache so severe that it seems as though his head

would split. He is dizzy, and his muscles are so weak that he may not be able to walk or even keep his head erect. Very commonly, there are far more serious aftermaths of CO gassing. The nature of such sequelae do not, however, depend for their character upon exposure to a definite concentration of the gas for a known length of time. The individual's idiosyncrasy to carbon monoxid is probably an important factor in determining the form which these sequelae of a more permanent nature will take. One man may be left paralyzed, another may lose his memory, a third his eyesight and a fourth his power of speech, and so on; yet each may have been subjected to practically identical conditions.

Poelchen (Gehirnerweichung nach Vergiftung mit Kohlendust. Berl. Klin. Wochensehr., 1882, V. 19, p. 396) remarks that in East Prussia it is generally believed that those who have survived CO gassing sooner or later show signs of mental deterioration. According to Lewin, these cases offer the greatest difficulty when it comes to deciding upon compensation. Poelchen describes the case of a woman who lay unconscious for two days as a result of carbon monoxid poisoning, but who apparently fully recovered and was able to attend to her household duties for more than two weeks. She then suffered a relapse, her limbs become more or less rigid, her power of speech was almost completely lost, and there was a marked mental apathy. Less than four weeks after the accident, she died of paralysis of the bowels. Lewin mentions a case of severe gassing which had apparently recovered in 36 hours except for headache, but twenty days after the accident the man had a relapse with increasing paralysis of the limbs which became complete on the twenty-fourth day and resulted in death the day following. Another victim was up and about for five or six days after the accident when he was seized with convulsions followed by paralysis of the jaw and death.

C. *Variations in Susceptibility*

There is a great difference in individual susceptibility to carbon monoxid as is shown by many accidents involving a large number of people. It has frequently happened that in mine disasters many of the men will be found dead while others in the same entry will survive. Some authorities feel that women

are less susceptible to carbon monoxid than men and point out that in a number of cases where whole families have been poisoned, the woman has escaped with her life, while the man and the children are found dead.

It has been noted around steel plants and in large automobile repair shops that some men appear to be immune to carbon monoxid. Experience has shown that these men are able to work in an atmosphere in which more susceptible persons would immediately succumb.

It is generally felt that middle aged men are less susceptible to carbon monoxid than are young men and those well along in years. Some foremen, in industries where minor CO gassings are of more or less frequent occurrence will not allow young men to undertake work where they are likely to be exposed to the gas. Where a group of men have been gassed, it is generally found that the young men are most quickly overcome and make the slowest recovery.

It is certain that in most cases the length of exposure, the percentage of carbon monoxid and other conditions such as the amount of carbon dioxid present and the diminished proportion of oxygen have a very important influence on the severity of the poisoning. But many cases are on record where brief exposure to small quantities of CO has caused death so that idiosyncrasy or individual susceptibility seems to play an important role. Again, one person may have been very seriously poisoned and yet make a very rapid and complete recovery showing no after-effects, while another who did not appear to be seriously gassed and who did not lose consciousness may develop very serious sequelae and even die.

D. *Tolerance or Immunity*

Some medical writers who have given much attention to the problem of carbon monoxid poisoning feel that this apparent immunity may possibly be accounted for by the development of a greater number of red blood corpuscles. As the oxygen carrying power of the hemoglobin is destroyed by combination with the carbon monoxid, new corpuscles are formed thus minimizing the loss of the oxygen carrying power of the blood.

It seems therefore that the question of idiosyncrasy is intimately bound up with that of establishing a tolerance or im-

munity to the gas. In a number of instances where whole families have been gassed, it is known that the mother, who was the only survivor, had for days previous to the fatal accident complained of headache, nausea, weakness of the limbs and other symptoms of carbon monoxid poisoning. The exposure during these days had probably led to a certain amount of tolerance being established. There are a number of cases on record of automobile repair mechanics who suffered from nausea, headache and other symptoms indicative of CO poisoning when they first commenced this work but in a few days' time they recovered from these symptoms and did not again experience them though they continued in the same occupation. On the other hand, there are on record cases of repair mechanics who did not recover and develop an immunity, but whose symptoms steadily became more severe until they were forced to give up this type of work. Health Commissioner Bundesen of Chicago reports that a number of traffic officers at busy corners where there is a heavy automobile traffic experience all the symptoms of carbon monoxid poisoning, until they got out into the fresh air of the open country when they fully recover. Other traffic officers have experienced these symptoms only when first going on duty though they may re-occur on days of extra heavy traffic. H. S. Forbes (A Survey of Carbon Monoxid Poisoning in American Steel Works, Metal Mines and Coal Mines. J. Ind. Hyg., 1921–22, V. 3, p. 11) believes that there is good evidence that men frequently exposed to the gas acquire a certain degree of tolerance to CO. He cites the instance of a mine foreman who on many occasions during his fifty years as a miner had suffered daily headaches for months at a time, but who was confident that he could stand the gas better than he could as a boy and that he was much less affected than a "greenhorn" would be.

The duration of the symptoms, as has already been noted, varies widely. It has been observed that in some cases a man may at first suffer severely when undertaking work in an atmosphere more or less contaminated with carbon monoxid, but after a short time these symptoms may disappear and not be experienced again unless the concentration of the gas is considerably greater than that normally encountered. With others the symptoms continue to increase.

E. *Chronic*

All writers appear to be agreed that slow gradual gassing is far more serious to a man than to be suddenly "knocked out" by a high concentration of the gas. Kober and Hayhurst define chronic carbon monoxid poisoning as the result of subjection to repeated continuous small doses of carbon monoxid which do not however produce at any one time a marked symptom complex. Dr. Hamilton (Industrial Poisons in the United States, p. 385) however says it is a disputed question whether prolonged exposure to small quantities of carbon monoxid produces chronic poisoning. The answer appears to hinge on an understanding of the term chronic poisoning. Lewin maintains that it can not be regarded as an accumulation of the gas in the body, which when it reaches a certain degree brings on characteristic symptoms. For this to happen, a person would have to remain continuously in air containing carbon monoxid, a condition which does not occur in life, as the CO acquired in contaminated air is always sooner or later thrown off in pure air. Therefore, according to Lewin a chemical accumulation does not take place and carbon monoxid can not act as a cumulative poison as occurs in the case of chronic lead, phosphorous or radium poisoning. However, there may be a cumulated effect of all the injuries indirectly done to the body tissues through the lessening of the oxygen carrying power of the blood. The injury may be simply a disturbance of cell nutrition due to anoxemia and resulting in the formation of toxic products which in turn produce their own effects. Henderson points out that parenchymatous degeneration of the tissues may be initiated by breathing carbon monoxid and that there is no known method of restoring these tissues to normal.

Glaister states that cases of chronic carbon monoxid poisoning may occur in any place where CO is given off in even small amounts and that it must not be forgotten that carbon monoxid poisoning owing to its cumulative action may occur even in the open air.

The symptoms of chronic carbon monoxid poisoning are so varied that it is very difficult of recognition, and its diagnosis is frequently arrived at solely by a process of elimination. It has often been mistaken for many other diseases. It has been erroneously called pernicious anemia. Pottenkofer has listed several

cases of CO poisoning that at first were diagnosed and treated as typhoid fever. Chapman feels that on many occasions cases of carbon monoxid poisoining have been mistaken and treated for lead poisoning. Pütz (Ueber Vergiftung durch Produkte der unvollständigen Verbrennung speciell durch Kohlenoxyd. Inaug. Dissert. Halle, 1882, p. 48) describes three cases of poisoning by charcoal vapour where a croupous membrane was formed which caused stenosis of the passage necessitating tracheotomy. Cases of CO poisoning showing an extensive diphtheric exudation have been described (Ziemessen quoted by W. Sachs. Die Kohlenoxydvergiftung in ihrer klinischen, hygienischen und gerichtsärztlichen Bedeutung. Braunschweig, F. Vieweg u. Sohn, 1900, 236 p.). Acute laryngitis and bronchitis are very frequent aftermaths of exposure to carbon monoxid. Landouzy (Lancet, No. 11, 1905) declared before the International Congress on Tuberculosis in Paris in 1905, that such symptoms as headache, giddiness, palpitation, nausea, weakness, etc., which he regarded as due to more or less continuous inhalation of small amounts of CO were ordinarily ascribed by the doctors to over-work, functional or organic disease of the digestive organs, neurosis, improper diet, etc. In such cases, all treatment tailed to cure the patient, until he had been removed to the fresh air of the country. Landouzy believed that frequent inhalation of small amounts of CO were undoubtedly one of the predisposing causes of tuberculosis. The part played by carbon monoxid in rendering persons, particularly miners, easily susceptible to tuberculosis is discussed at some length by the Transvaal Phthisis Commission.

A considerable number of physicians who have given attention to the effects of small amounts of carbon monoxid upon man are of the opinion that a truly large variety of ailments of doubtful etiology may be found to be manifestations of chronic carbon monoxid poisoning when all the data are available.

The milder manifestations of chronic CO poisoning are likewise many and varied. An early and very common symptom is frequent and often intolerable headaches which, when exceptionally severe are accompanied by nausea and vomiting. A peculiar feature of headaches of this origin is that they frequently do not occur until the patient leaves his work and goes out into the open air or at least away from the carbon monoxid.

Attacks of giddiness are very common; another frequent symptom is a lack of muscular control that causes a man to stagger as he walks and is associated with marked fatigue. At times the symptoms of chronic carbon monoxid poisoning closely resemble those of alcoholism. Glaister, Lewin and others who have had much experience in medico-legal work feel that, on not a few occasions, justice has miscarried and a man has been pronounced "drunk" when he was actually suffering from CO poisoning.

Frequently the digestive system is deranged; there is a marked loss of appetite and food does not taste as it should. Shumway (Chronic Carbon Monoxide Poisoning, An Increasing Danger to Municipalities from Automobile Traffic) calls attention to cases that at first were thought to be suffering from ulcerations of the stomach, but it was ultimately shown that they were suffering from the effects of chronic carbon monoxid poisoning.

Loss of sleep is not uncommon; other patients lose their sense of taste or smell to a great extent; while still others have had their eyesight so disturbed that they have placed themselves in the hands of oculists who, not recognizing the source of the trouble, have failed to give relief.

Lewin, Glaister and others have called attention to the danger of pregnant women being exposed to carbon monoxid as the gas may pass from the mother's blood into the blood of the foetus. There are quite a few cases on record of a mother having survived CO gassing and later giving birth to a dead child. Lewin believes that there is evidence to show that an amount of carbon monoxid in the mother's blood which is too small to produce symptoms in her alarming enough to attract attention may be sufficient to kill the child in utero and that such poisoning is probably fairly common in industries where women are employed and where the air is contaminated with carbon monoxid. In early Roman days the smoke from extinguished candles was inhaled to bring on premature labor.

F. *Relapses*

Dr. Hamilton (Industrial Poisons in the United States, p. 385) states there is also a relapsing form of carbon monoxid poisoning in which, after apparent recovery and a period of fair

health, serious symptoms which may result in death or insanity suddenly develop. It is very probable that this so-called relapsing form of CO poisoning is but a delayed manifestation of the very great variety of sequelae following slow, gradual chronic carbon monoxid gassing.

A list of the forms in which relapses from CO poisoning may manifest themselves would prove voluminous, but among the more common may be mentioned pneumonia, particularly bronchial pneumonia, blindness, deafness, permanent weakness, paralysis of various forms, delirium, dementia, amnesia, loss of will power, loss of speech, aphasia, nervous disorders, and a breaking down of the various body functions.

These manifestations may appear some time after exposure to carbon monoxid without the patient previously having been thought of as a victim of CO poisoining; yet such disturbances may rightly be classed as sequelae of carbon monoxid gassing.

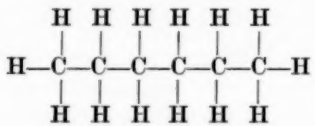
IV

Composition of Gasoline

The character of gasoline varies in different parts of the country, but generally it may be considered as that portion of crude petroleum which distills at temperatures between 140° F. and 158° F., and which has a specific gravity of from 0.636 to 0.70. The product that distills below 140° F. is known as Chymogen, and that above 158° F. as benzine or naphtha.

Gasoline is a combination of the hydrocarbons, pentane, hexane and heptane with some impurities which however seldom reach, in the gasoline readily available at public filling stations, a percentage that would warrant their consideration in this discussion.

The major constitutent of gasoline is hexane, a hydrocarbon of the formula C_6H_{14} with the following molecular construction:



It may be computed that this represents a composition of closely 83.7 per cent. carbon and 16.3 per cent. hydrogen.

For the present purposes gasoline may be considered as composed solely of hexane, as pentane (C_5H_{12}) is 83.3 per cent. carbon and 16.7 per cent. hydrogen, and heptane (C_7H_{16}) varies as little in the other direction in its carbon and hydrogen content.

When the explosion occurs in the automobile engine the carbon atoms in the gasoline vapor combine with some of the oxygen of the air to form carbon dioxid (CO_2) while the hydrogen unites with more oxygen to form water (H_2O). Using the atomic weights as coefficients, the following weight proportions are obtained:

(1) $$12\ C + 32\ O = 44\ CO_2$$

(2) $$2\ H + 16\ O = 18\ H_2O$$

V

Combustion

Considering now the weight of air theoretically necessary to secure complete combustion of the gasoline vapor, using as a basis one pound of gasoline and recalling that this substance is practically 83.7 per cent. carbon and 16.3 per cent. hydrogen, the following equations are obtained:

(3) $$0.837\ C + \frac{(32)}{12}\ 0.827\ O = \frac{(44)}{(12)}\ 0.837\ CO_2$$

(4) $$0.163\ H + \frac{(16)}{(2)}\ 0.163\ O = \frac{(18)}{(2)}\ 0.163\ H_2O$$

(5) $$0.837\ C + 2.216\ O = 3.053\ CO_2$$

(6) $$0.163\ H + 1.302\ O = 1.463\ H_2O$$

Total oxygen: 3.518 pounds of oxygen required to vaporize one pound of gasoline.

It must be remembered, however, that air is composed of approximately 23 parts of oxygen and 77 of nitrogen. Therefore the 3.518 pounds of oxygen theoretically required for the complete combustion of the gasoline is mixed with $\frac{77}{23} \times 3.518 = 11.774$ pounds of nitrogen. Hence theoretically about 15.3 pounds of air are necessary to secure the complete combustion of one pound

of gasoline. As a matter of fact, the air is never fully diffused through the gasoline vapor in the cylinder of an automobile and nearly 16 to 17 pounds of air are needed. At this point a maximum efficiency from the standpoint of gasoline consumption is secured. This air to gasoline ratio is, however, seldom maintained and whenever the maximum power of which the machine is capable is desired, the ratio of air to gas is dropped to 11.5 or even 10 to 1.

It may be seen that unless sixteen parts of atmosphere air are mixed with each part of gasoline vapor there will not be sufficient oxygen present for two atoms of that element to combine with each atom of carbon in the gasoline radicle. When sufficient oxygen is not present, each atom of carbon can unite with but a single atom of oxygen forming CO, carbon monoxid, which is given off in the automobile exhaust.

The problem of securing the best possible combustion, then, is in no small measure, to get at least 16 parts of atmospheric air thoroughly mixed with 1 part of gasoline before ignition takes place. The smaller the volume into which a unit volume of this explosive mixture is concentrated, the greater the proportional power of the motor.

One solution of the inter-related problem of fuel economy and power lies in increasing the extent to which the air and gasoline vapor may be compressed before ignition takes place.

American automobiles have as an average a compression ratio (the ratio of the total volume of the cylinders with the piston at the bottom of its stroke to the cylinder volume when the piston is at its highest point) of 3½ to 4½ to 1. Increasing the compression ratio from 4½ to 1 to 7 to 1 would theoretically increase the efficiency of the engine about 25 per cent. (Ricardo).

As compression is increased not only is the ignition point of the fuel decreased, but the temperature of the gas-air mixture increased. Unfortunately then, there is a point beyond which compression in the cylinders cannot be carried before spontaneous combustion occurs. Many attempts have been made to decrease the reaction velocity of combustion of gasoline vapor in order that the cylinder compression may be increased, thus permitting a greater volume of air to be mixed with a unit volume of gasoline vapor before ignition takes place, thereby increasing

the efficiency and at the same time securing a reduction of carbon monoxid in the exhaust gas.

VI

Composition of Exhaust Gas

Unfortunately however, one hundred per cent. combustion of the hydrocarbons in gasoline is not attained even with the best possible adjustment of the carbureter and perfect timing of the spark. Depending primarily upon the care with which the carbureter is adjusted, the amount of carbon monoxid in the exhaust gases of an automobile may vary from slightly under two per cent. by volume to thirteen per cent. or even more. During the summer months when the air is warm, a unit weight of air will occupy a considerably greater volume; hence with the same carbureter adjustment, a smaller amount of oxygen will be sucked into the cylinder with a consequent greater percentage of carbon monoxid in the exhaust.

The amount of incompletely burned carbon increases rapidly as "a richer mixture," that is, a lower air-gasoline ratio, is used. This condition commonly prevails when the machine is being "warmed up" or when greater power is needed for hill climbing or heavy pulling.

A low air-gasoline ratio means, in addition to a greater volume of carbon monoxid in the exhaust, fewer miles per gallon of gasoline. In the United States where gasoline is relatively cheap, the mileage per gallon is of but minor import as compared with an engine that starts easily in any kind of weather and continues to run without requiring any attention or adjustment. In foreign countries where gasoline is almost a luxury, fuel economy is of vital importance. We are apparently satisfied with ten to twenty miles per gallon, and have almost persuaded ourselves into believing that is all we should expect. On the other hand, French economic tests showed a Voisin limousine weighing 5000 pounds ran 28.3 miles per American gallon, a Citroen car weighing 2500 pounds ran 53 miles, and a Petite Peugot weighing 1200 pounds ran 76.9 miles per gallon. Assuming that the volume of carbon monoxid in the exhaust from any one of these French cars is as much as that from the average American automobile, it would appear that a French car which doubles and even triples the mileage, emits but one-half to one-third of the CO which

results from traveling the same distance in an American automobile.

The average composition of the exhaust gas by volume of 23 cars in this country is shown in the following table:

	On Level Grade Per cent.	Ascending 3 Per cent. Grade Per cent.
Carbon Dioxid	8.6	9.6
Oxygen	2.3	1.3
Carbon Monoxid	6.3	6.4
Nethane	0.9	0.6
Hydrogen	3.0	2.9
Nitrogen	78.6	79.2

There were 988 cubic feet of exhaust gas at 65° F. and 29.92 inches of mercury from one gallon of gasoline. From this it may be figured that there were 62.2 cubic feet of carbon monoxid; also that 29.5 per cent. of the total heat of the gasoline goes out in the exhaust in the form of combustible gases; and that if the completeness of combustion averaged but 70.5 per cent. for twenty-three American cars under common operating conditions, the loss of nearly one-third of the energy of the gasoline does not speak well for the efficiency of the automobile in this country.

At present, even the small cars produce as much as one cubic foot of carbon monoxid per minute while larger cars, trucks and buses produce much more. With the present design of engine exhaust this poisonous gas is discharged at the rear of the automobile about fifteen inches above the ground. As carbon monoxid has practically the same density as air (0.9678), there is but a very slight tendency for it either to rise as would hydrogen or settle to the pavement as does a heavy gas like carbon dioxid, another constituent of automobile exhaust.

It is of considerable importance therefore to know as exactly as possible what becomes of the carbon monoxid after it leaves the exhaust pipe of a gasoline driven motor vehicle.

VII

Carbon Monoxid in Street Air

Under the direction of the Public Health Committee of the New York Academy of Medicine a series of observations were

made showing the distribution of the exhaust gas back of a car when standing still but with the motor running. It was found, as a result of observations made on a Ford car that the gas is distributed in a cone shaped space which spreads out so that the head of a person, of average height, standing a few feet back of the car was surrounded by an atmosphere conatining from 4 to 6 parts of carbon monoxid per 10,000 of air.

A second series of observations were made upon cars travelling approximately ten miles per hour. Under such conditions the cone of exhaust gas is elongated and the occupants of a car following about 30 feet behind are surrounded by exhaust gas diluted to 1 or 2 parts of carbon monoxid in 10,000 of air.

Owing to the nature of carbon monoxid, that is, its density being practically the same as that of air, and the direction in which the exhaust is discharged from automobiles, the gas tends to hang in the street in a layer from 5 to 10 or at the most 15 to 20 feet deep. The concentration of the monoxid at a point the height of a man's head above the pavement depends largely upon atmospheric conditions. In a brisk wind, as might be expected, the dangerous fumes are more quickly diluted with fresh air and dissipated to higher elevations, but on the other hand, on damp days when the air is heavy and the wind velocity almost nil, high concentrations of this dangerous gas may be expected at points of heavy traffic.

With the facts established that carbon monoxid was to be found in the street air in the wake of an automobile whose engine was running, the next question was to determine the proportion of this gas encountered under different traffic concentrations with varying atmospheric conditions.

To this end a Ford car was equipped for the collection of samples. Two general types of samples were taken; those termed "snap" or "grab" samples of roughly a liter in volume, taking from 15 to 18 seconds to collect, and the composite sample to show average conditions over a quarter, half, or even three-quarters of an hour. In general an effort was made to obtain samples showing the conditions when traffic was light or of but moderate volume, and again when it was most dense, particularly during rush hours on clear windy days and also at times when the air was damp and still.

While the results vary, as may be expected according to atmospheric conditions and the amount and movement of traffic, the figures show conclusively that one part of carbon monoxid in 10,000 of air is a quite frequent condition in certain streets at certain hours and two parts are not unusual. An even greater concentration occurs in limited areas and for short periods. At times of moderate traffic on clear windy days, carbon monoxid is not present in sufficient quantities to constitute an appreciable health hazard. However, even at such times a stop behind several other cars resulted in the collection of samples of air containing a fairly high concentration of carbon monoxid. Almost without exception these relatively high concentrations were found immediately back of omnibuses.

Owing to their large motors with consequent high gasoline consumption and their frequent stops and starts, when an exceptionally large volume of carbon monoxid is produced, the omnibuses do more to contaminate the air with this dangerous gas than any other equal number of vehicles with the sole possible exception of large trucks.

VIII

Reported Effects of Carbon Monoxid in Street Air

On damp still days the carbon monoxid content of the street air mounts, during heavy traffic, to a point where, according to Professor Yandell Henderson, a distinct health menace is created.

A number of writers have expressed the opinion that not a few automobile accidents have been caused by the mental dullness and inability of an operator to co-ordinate his movements in consequence of his being more or less under the effects of the carbon monoxid given off in the exhaust of the machines about him. Frequent references may be found to the headaches and dizziness of the occupants of automobiles caught in a long line of slow moving traffic. It is well recognized that with some individuals the eyesight and the co-ordination of muscular movements are affected by relatively minute quantities of carbon monoxid. A man who has inhaled such amounts of carbon monoxid as are present in garages is frequently affected by the same kind and degree of weakness of judgment and of accuracy of co-ordination as a man under the influence of a comparable amount of alcohol. Cases of

carbon monoxid coma caused by leaky exhaust heaters in closed cars have been recorded.

As a group, the traffic officers of large cities who are required to stand for hours at points of heavy automobile traffic, are those most likely to feel the effects of the carbon monoxid in the exhaust gases. Unfortunately there are practically no data available for New York City on the absenteeism or other conditions among traffic officers that may justly be attributed to monoxid. Certain information is, however, available from Chicago.

The results of an inquiry by City Health Commissioner Bundesen of twenty-five policemen at crossings in Chicago where automobile traffic is heavy, indicated that almost without exception, they complained of fatigue, dryness in the throat, headaches, and bronchial irritation, all symptoms distinctly indicative of carbon monoxid poisoning. It is quite significant in Dr. Bundesen's opinion that these officers seek living quarters in out-lying districts so as to be removed as far as possible from the automobile exhaust to which they attribute their discomfort. Many of these traffic officers stated that when on furlough the symptoms practically disappeared; but upon resuming duty, the distressing signs re-manifested themselves. They further stated they are not affected so severely in the winter, or when the wind is strong, but they feel the worst on hot humid days.

Dr. Shumway referring to conditions in Philadelphia states that the effect of automobile exhaust gases on the traffic policemen at busy places is well known. Dr. Hubley Owen, Chief Police Surgeon of Philadelphia, reports that traffic officers frequently complain of headache and nausea at the end of the day's work. "The foot-traffic patrolmen (at the ferry houses) complain of gastric disorders more frequently than the men from the districts. In many cases these symptoms have actually been so persistent that I have sent them to the hospital for gastro-intestinal X-ray study, and gastric analysis. I find that these studies are negative, and that after the men have had a few days' rest from their traffic duties, their symptoms have been relieved."

That the policemen of New York City are no different as far as their ability to withstand monoxid poisoning from those in other cities is shown to some extent by an article published in the New York Sun, November 13, 1924, stating that figures in the traffic

department at Police Headquarters show that 100 out of 1200 men assigned to traffic duty are out each month because of illness much of which is of a bronchial nature. The same article mentions the headaches experienced by one of the traffic squad and comments that it is of the same type as that which the motorist experiences on Sundays when he crawls along at eight miles per hour in the wake of hundreds of other motorists "out for the air."

An article in the Tribune of December 21, 1924, states that the people of Paris are in revolt against the pollution of the air by automobile exhaust.

Dr. Shumway learned from the starter at the taxicab stand at the Broad Street Station in Philadelphia that when seven to ten cars are running the air is so bad that he goes home each day suffering from a headache, nausea, and a loss of appetite, which his physician cannot relieve. In the warm weather when the doors to the station are open many of the ticket sellers suffer from typical symptoms of chronic carbon monoxid poisoning.

The conditions at the taxicab stands under the Grand Central and Pennsylvania depots are particularly dangerous. At these points a considerable number of motor vehicles congregate with their engines running ready to "pick up a fare." The ventilation, particularly at the Grand Central Depot where there is a stand for a number of taxis under the main thoroughfare, is bad at times, especially on warm, damp days when the air is still; and there is every reason to believe that the carbon monoxid content of these vehicular subways must at times reach a concentration so considerable that exposure for as short a period as thirty minutes would be dangerous.

The ventilation of the New York-New Jersey traffic tunnel has been so designed that users of the tunnel will not be exposed to a concentration of more than 0.4 parts of carbon monoxid per 10,000 of air for more than thirty minutes. Many automobile engineers and other authorities fear, however, that a broken down truck or some similar accident will cause the carbon monoxid content of the tunnel air to exceed the danger point before the trouble can be corrected.

The danger of explosion of a gas tank following fire is recognized by those who have in mind the large number of automobile

fires which occur on the bridges over the East River and at other points not easily accessible to fire apparatus. It has been suggested as a means of materially lessening these dangers in the traffic tunnel, that the tunnel be provided with a moving platform, which will transport every vehicle from one end to the other. If this suggestion is adopted every automobile engine can be stopped the moment the machine is driven upon the platform. Thus carbon monoxid would be entirely eliminated, and the danger of fire greatly diminished.

If the number of automobiles continues to increase at the present rate it is estimated that New York will have more than 1,000,000 cars by 1930. If, by that time, definite action has not been taken to lessen the amount of carbon monoxid present in automobile exhaust the condition of the street air will be so bad that many people in the city may be dangerously poisoned.

As a general rule comparatively few small cars or electrically driven vehicles are seen upon Fifth Avenue in the vicinity of 42nd Street, consequently, with the knowledge we now possess of the amount of carbon monoxid commonly found in the exhaust of heavy cars and omnibuses, it is quite safe to assume that an average of at least 1.8 cubic feet of carbon monoxid is being discharged from each machine passing that corner each minute. On this basis the cars on Fifth Avenue alone are discharging every minute of the twelve hours between 7 in the morning and 7 at night, an average of between 48 and 50 cubic feet of this gas, more than 30,000 cubic feet in a day.

If there were no wind stirring to disperse the carbon monoxid from the exhaust of the motor vehicles passing this point, the air would be polluted to a point quickly fatal to life. Not less than twenty million cubic feet of pure air during the twelve daylight hours must be mixed with the exhaust if a serious menace to life is not to be encountered.

These rough estimates showing the volume of carbon monoxid frequently being discharged from the exhaust of automobiles at a point where the traffic is as congested as it is at 42nd Street, are based upon north and south traffic only. According to the police, traffic along the Avenue operates for but forty-two minutes (42) out of every hour. The crosstown traffic during the eighteen (18) minutes when the north and south traffic is

held up is considerable. The figures for the amount of carbon monoxid discharged into the street air at Fifth Avenue and 42nd Street could, in all probability, be increased by one-sixth without overstating the volume of CO that actually is present in the exhaust gas discharged between 7 a. m. and 7 p. m. on days of average heavy traffic.

IX

Problem of Carbon Monoxid in Garages and Repair Shops

The great danger of carbon monoxid poisoning from automobile exhaust gases in closed private garages has already been touched upon. In public garages conditions are less threatening to life, but undoubtedly more continuously inimical to health. The newer garages with their tight walls and ceilings are, on the whole distinctly dangerous from this standpoint. Present methods of artificial ventilation are far from effective for when an engine is run idle in testing and adjusting, or when cars move slowly in entering or leaving the garage, the exhaust gas is blown out in such a manner that it is rapidly mixed with the air of the whole, or at least a large adjacent portion of the garage. Forced ventilation, to be effective, should change the air of the garage every few minutes. In winter, when it is most needed, ventilation on such a scale is impracticable, for it would soon reduce the temperature of the garage nearly to that prevailing out-of-doors. The conditions obtaining in public garages have been studied by the New York State Department of Labor and by Dr. Alice Hamilton and others.

Very few of the large garages have any ventilation worthy of the name. In consequence of this, the typical carbon monoxid headache is a frequent and in some cases a daily occurrence with many of the employees.

In repair shops and assembling rooms the conditions are much worse. The answer to an inquiry made at one shop as to how many of the men go home with a headache was "Nearly all of them nearly every day, but we try not to run tests and make much gas until closing time." One assembling plant where engines are tested before being placed on the chassis is anxious to learn of some means of reducing the large amount of time which the employees lose from work on account of headache and nausea.

X

Smoke and Odor Nuisance

Motor vehicles are frequently responsible in varying degrees for still another form of air pollution along the highways, namely smoke and odor. This nuisance appears to become less noticeable from year to year. Formerly the majority of automobiles emitted evil smelling smoke from their exhaust pipes, but now the smoke nuisance is considerably reduced and the odor of burned oil is equally uncommon. Credit for this change for the better, is largely due to better automobile design. It is now generally recognized that not only is there no real need of having a smoking automobile, but that considerable smoke in the exhaust represents either careless, wasteful operation or an imperfectly designed machine.

It will be a difficult problem to eliminate the tarry soot that is commonly present as a by-product of the combustion of most of the gasoline now available. There is however, no reason why burned oil should be present to an appreciable degree in automobile exhaust.

Despite the great change for the better made in the past few years in the character of automobile exhaust from the standpoint of smoke and odor, there still remains room for improvement. The amount of smoke in the exhaust of any particular machine may appear small, but when combined with that from many other cars, the effect is noticeable.

There are laws in most states against discharging dense smoke from the exhaust pipe. The principle of such legislation is laudable, but enforcement for the most part is difficult and perhaps, therefore, lax. "Dense smoke," which is prohibited, is so hard to define that few courts will convict unless the exhaust is so bad that an intolerable nuisance has been created. The law has effect, however, in that the desire to avoid arrest has caused many to give more thought to their oil problem than might otherwise have been the case.

What steps may be taken to relieve the menace to life and health from the carbon monoxid in the automobile exhaust? The whole problem is difficult, but that for the repair shops and assembling plants appears to be easiest of solution.

It has already been noted that any attempt to change the entire air content of a building used for automobile assembling, testing and repairing as frequently as would be necessary if all health hazards are to be eliminated is out of the question. To heat the enormous volume of incoming air to a suitable degree would on cold days require an amount of coal or other fuel far beyond an economical point.

The solution of the problem for assembling rooms, repair shops, etc., would appear to lie in providing flexible ducts that might easily and quickly be attached to the exhaust of each engine being tested. These ducts should be under suction so that there may be no danger of the monoxid escaping into the work room. Numerous flexible ducts might well be connected into the main stack so that the gases together with the smoke and gases from the boiler room would finally be discharged above the building.

It is quite probable that the method finally adopted in repair shops and engine testing plants for eliminating or otherwise reducing to a minimum the carbon monoxid from the exhaust of automobile engines will not prove effective for storage rooms and similar places.

The danger of monoxid poisoning in garages and points where automobiles are stored and where there is frequent movement of the machines to and from the building can not be met in any such comparatively simple manner. The problem of such places differs from that of our highways in degree only and is not going to be met properly until the question of ridding automobile exhaust of carbon monoxid or discharging it in a manner not detrimental to animal or plant life has been solved.

XI

Reduction of Carbon Monoxid in Exhaust Gas

There are five fairly distinct lines of procedure that suggest themselves for eliminating or reducing carbon monoxid in the exhaust: first by so adjusting the carbureter that this dangerous gas will not be produced; second, by securing a more intimate mixture of the air and gasoline vapor that the speed and completeness of ignition may be enhanced; third, by so designing the motor that a greater air to gasoline ratio may be used without material loss of power; fourth, by the development of a gaso-

line that will permit a higher compression ratio; fifth, having the outlet for the exhaust at a point where the street air will not be contaminated seriously; sixth, eliminating the monoxid after it has been produced, but before it is discharged into the open air from the exhaust pipe.

While it is theoretically possible to introduce enough air into the cylinder of an automobile engine to convert completely all the carbon in the gasoline vapor into carbon dioxid, it has not been found practically possible to accomplish this end. Careful adjustment of the carburetor to gasoline supply, spark timing and atmospheric conditions will in some carbureters secure a very high percentage combustion, but one hundred per cent. reduction of the carbon monoxid in the exhaust appears to be impossible of attainment. This is possibly due to the fact that the presence of carbon dioxid or even carbon monoxid itself retards the combustion of the latter gas.

The better design of carbureters can, however, be so adjusted that, under average operating conditions, but two (2) per cent. or even less of the exhaust gases is carbon monoxid. As a general experience, however, the motor vehicles in New York are discharging exhaust gases containing from six (6) to ten (10) per cent. monoxid or more. There is no excuse for the amount of this gas at any time exceeding six (6) per cent.

Even if one hundred per cent. combustion could be secured by adjusting the carbureter to care for one definite set of conditions, the least change in any of the several factors that are controlling will occasion some monoxid being produced. Changes in atmospheric conditions could be cared for readily, but the need for more power for hill climbing, pulling out of a bad spot, or for any other purpose that occasions a retarding of the spark and an increase in the gas supplied to the engine would, for the time being at least, vitiate the good results secured by hair-line adjustment of the carbureter.

There are two ways in common use for meeting this situation. One is to supply a choke to shut off the main air supply to the carbureter, thus enriching the mixture and the other is to provide a means of adjusting the carbureter from the dash or the steering post.

The dash adjustment can be made very simple in action if it is used correctly. Its use is easily understood, because its object is

to get it set to supply as "lean a mixture" as is possible. It can readily be told when it is too lean, for the engine will lose power and backfire through the carbureter. A proper dash adjustment set correctly for one speed and load will be correct for all speeds and loads at the same temperature. The carbureter will then need to be changed only as the temperature varies.

The mixture should be just right for a hot engine with the dash adjustment set at its leanest position. A carbureter adjusted for the maximum miles per gallon will deliver too lean a mixture to develop the full power of the engine. In general, the maximum mileage is secured when the air-gasoline ratio is approximately one to sixteen (16). At this ratio the amount of carbon monoxid in the exhaust is at its lowest point, being less than two (2) per cent. The brake horse-power is slightly over ninety-one (91) per cent. of the maximum that may be secured.

The point of maximum power appears to be reached when the air-gasoline ratio has been decreased to approximately twelve and six tenths (12.6). To secure this additional nine (9) per cent. of power, more than sixteen (16) per cent. of the possible mileage is sacrificed and the carbon monoxid in the exhaust gases increased practically two hundred to three hundred (200–300) per cent.

It will be seen then that even under present conditions a very marked and, from the standpoint of fuel economy, valuable reduction in the carbon monoxid content of motor exhaust gases may be secured by proper adjustment of the carbureter. The gain in power afforded by using a "rich mixture" is not great enough to be a legitimate excuse for the low air-gasoline ratio which is commonly used in a vast majority of automobiles in this country, and which is responsible for an inordinate amount of carbon monoxid in the exhaust.

The automobile owners and operators of the United States should be brought to realize that their desire to have an engine which will start promptly on cold days is, even with the present comparatively low price of gasoline, costing them many thousands of dollars each year. The demand for a quick starting motor is an important factor in the depletion of the available gasoline supply of this country.

In spite of the very frequent warning in the press that our known sources of gasoline may be exhausted within a quarter of

a century, there are but very few who appear to realize that they are playing an important part in this depletion of an invaluable national resource. If the price of gasoline were fifty or sixty cents a gallon, as it now is in England, the American public would be quick to learn more about the carbureters on their automobiles, and demand a less wasteful adjustment even at the expense of a little more time and effort in starting the engine.

It is not likely that automobile owners will of their own accord insure that the carbureter is maintained at a proper adjustment. Consequently as a health protective measure, legislation could be enacted or at least police regulations adopted to the effect that no automobile shall be operated upon the city streets, if the exhaust gases show a greater carbon monoxid content than four (4) per cent. by volume.

A few years ago, it would have been practically impossible to enforce such a regulation, owing to the difficulty of collecting samples of the exhaust for analysis, and the complexity of making the necessary tests. Recently, however, the Bureau of Mines of the Department of the Interior, has devised an apparatus that will give almost instantaneous readings of the CO content of air. It is felt that this machine will be developed to such an extent that it will show either on a dial or on a recording drum the carbon monoxid per cent. at any instant at any desired point. It should then be relatively simple to equip a police car with this apparatus and make determinations of the exact amount of monoxid present in the exhaust of any automobile which the police may feel is failing to keep within the limit set.

It would not take many fines to insure that practically every machine being operated in the city was complying with the law. It is also quite probable that instead of being just on the safe side, the average for all automobile exhausts would be as low as three (3) per cent. carbon monoxid.

More than carbureter adjustment should be considered, however, in order to secure a solution of the vital problems of eliminating or very largely reducing the carbon monoxid content of the exhaust from motor vehicles, and at the same time maintaining a high efficiency with a maximum of power.

It is a well-known and established fact that the efficiency of internal combustion engines increases with the compression

ratio. At first an increase in the compression ratio over that commonly in use secures a marked increase in efficiency. At a certain point, however, practically no increase in efficiency is obtained by a further increase in the compression.

Recently in an effort to develop a more efficient internal combustion engine detailed investigations were conducted of various catalytic agents to determine their serviceability for securing more complete and rapid combustion of the fuel mixture. Ultimately a catalyzer was found which when introduced into the cylinder head of a gasoline engine apparently causes a more intimate mixture of the molecules of the fuel vapor and the air, and at the same time owing to the high coefficient of radiation of this catalyzer it has the effect of increasing the volatibility of the mixture to as great an extent as most preheating devices. As a result automobile engines treated with this agent appear to show a greater efficiency and a nearer coincidence of maximum power with the point of greatest fuel economy.

To secure a higher efficiency a greater number of the available heat units in the fuel must be utilized. This can not be accomplished unless the fuel mixture is more completely burned. As has been seen, complete burning of the gasoline would wholly eliminate carbon monoxid except of course the relatively small amount that may be occasioned by a breaking down of the carbon dioxid actually formed at the time of combustion. Hence any increase in engine efficiency from the thermal standpoint means a corresponding reduction of the carbon monoxid. It is therefore quite probable that some such agent may prove a large factor in the reduction of the CO in automobile engine exhaust.

One of the outstanding problems confronting automotive engineers in attempting to construct motors of greater economy is that of eliminating the "knock." Recent investigations of the detonation or "knock" in internal combustion engines, especially of the high compression type, has demonstrated that it can be practically eliminated by increasing the reaction velocity of combustion. It is known that the reaction velocity may be increased by adding small quantities of certain compounds such as alcohol, toluene, tetraethyl lead, etc., to the gasoline. This makes it possible to use engines of a higher compression ratio, thereby increasing the mileage per gallon of gasoline consumed.

Already a gasoline has been developed that, according to the inventors, with the type of cars in common use will give nearly twice the mileage per gallon of that secured from the regular grades of gasoline. It is felt that a smaller amount of carbon monoxid will be produced from a unit volume of such gasoline, but as yet studies have not been carried out to determine this point. However, even if the proportionate amount of monoxid is the same as produced by the standard gasolines the concentration at any point will be but approximately one-half that now encountered owing to its being distributed over roughly twice the distance.

It will be seen, therefore, that modification of the character of the fuel used in automobile engines may materially assist in reducing the carbon monoxid in street air. Changes in the gasoline used will probably lead to changes in engine design, which will still further assist in solving the problem of dangerous pollution in street air by automobile exhaust gases.

It has been suggested that the present location of the exhaust pipe near the ground at the rear of the machine is particularly menacing, and that automobile exhaust should be considered and treated in the same manner that smoke and gases from a furnace are handled.

The exhaust gases from automobile engines are far more toxic than the smoke which rises from the chimneys of dwelling houses or from the smoke stacks of most factories or the funnels of locomotives. In amount the total volume of automobile exhaust gas discharged even in a single street of New York City daily is not less than that of a large factory or power plant.

Henderson in a report prepared two years ago maintained that if the exhaust gas of automobiles constantly contained soot particles or what is termed "smoke" there would never have been any question that the automobile engine should be provided with a chimney. The exhaust gases being, however, nearly colorless, only slightly impregnanted with finely divided and suspended soot, and comparatively free from odor, the practice of discharging the gases under or behind automobiles has become universal.

While this suggestion for chimneys for automobiles does not appear practicable, it is nevertheless fitting that it should be discussed in some detail before it is discarded as not being of the

character needed to relieve the problem that New York City must soon face.

If the engine exhaust were discharged above the heads of pedestrians the danger of monoxid poisoning would be greatly lessened. The movement of the motor vehicles would, of course, tend to suck a portion of the exhaust towards the pavement, but the tendency of carbon monoxid to rise, though slight (0.9678 to 1.0000) would help to counteract the suction of the machine. The gas being warmer than the surrounding air continues to rise while cool relatively fresh air drifts downward along the walls of the buildings beside the street to replace the rising gases from the machines. Thus at the same time, the exhaust gases are largely prevented from entering open windows.

Professor Henderson was of the opinion that a measure of amelioration would be secured if it were made a legal requirement that all trucks and omnibuses, all taxicabs and commercial vehicles, and all passenger cars with permanent tops discharge their exhaust gases through a pipe extending vertically upward for at least a few inches above the highest point of the roof. This suggestion has already been seized upon by a number of newspaper cartoonists as bizarre and a worthy object of humorous jibes.

Professor Henderson maintains that the benefits to be secured from vertical exhaust are not confined solely to street traffic. In private garages, owing to the natural tendency of the relatively warm monoxid to continue to rise, a ventilator in the roof immediately above the vertical exhaust will serve to remove the greater part of the gas before it can mix with the air in the room.

In the large public garages the problem of maintaining reasonably good ventilation without excessive costs for power and heat, now practically impossible of solution, will be greatly simplified. Exhaust gases discharged vertically rise to the ceiling and spread out in a stratum which scarcely mixes at all with the air below. Owing to its heat and consequent lightness it seeks any vent. Thus by providing a number of vents in the ceilings of buildings either with or without suction, the deleterious gases will for the most part be quickly removed.

Though the vertical exhaust pipe may help, it does not appear to be a good solution of this intricate problem. Certainly,

if future studies prove that it is automobile exhaust that is deleterious to the foliage of the city trees and shrubs, the vertical exhaust will not help this situation. At its best the carbon monoxid is not lessened but merely carried to a point where the atmosphere is less apt to be affected.

The possibility of reducing the carbon monoxid content of the exhaust as it leaves the engine cylinders but before it is discharged into the open air should be considered. Naturally, the first line of attack that suggests itself is to convert completely the CO in exhaust gases into CO_2.

The statement that carbon monoxid and oxygen when heated combine to form carbon dioxid must be qualified as it is not strictly true. Certain experiments conducted in Germany have shown that perfectly dry carbon monoxid mixed with pure dry oxygen does not ignite to form the dioxid. This fact, however, need not be considered in the present question, as one of the products of the combustion in the cylinder is water, and water vapor is therefore present to a great extent in the exhaust. In fact, it is steam in the exhaust that many mistake for thin white smoke.

For other reasons, however, it is out of the question to collect the exhaust in any chamber, add more air and with the aid of a spark or even a continuous flame, hope to convert the carbon monoxid into carbon dioxid.

The main difficulty is that the amount of the monoxid in the exhaust is relatively very small. It is mixed with a large volume of nitrogen which being an inert gas is still present in the exhaust as nitrogen, with considerable carbon dioxid and with water vapor. Adding more air to the exhaust to supply oxygen so that the combustion of the monoxid may be completed will merely serve to dilute the gas with nitrogen to a still greater extent.

Other means must be sought for reducing the carbon monoxid in the exhaust.

There are two general procedures that may be considered for this purpose. Either the gas may be absorbed as carbon monoxid or some catalytic agent introduced into the exhaust pipe that will convert the monoxid into the dioxid without itself entering into the reaction.

Considering the possibility of absorbing the gas, it is known that at a dull red heat a unit volume of iron absorbs 4.15 vol-

umes of the monoxid. One volume of wood charcoal will absorb 21.2 volumes of CO, while a solution of cuprous chloride in hydrochloric acid readily absorbs the gas. It will be seen that none of the substances readily available absorbs a sufficient volume of the monoxid to warrant its use in automobiles. Even if an agent were available that would readily take up large volumes of this gas, its use would be of doubtful value. It would require undue police supervision to insure that automobile operators replaced the absorptive agent whenever it needed replenishing and did not attempt to drive their machines when the monoxid gas could no longer be taken up, but was being discharged into the open air. Again it is enough of a duty to have to fill the gasoline tank and most automobile owners would consider it a hardship to have to recharge a container for getting rid of an unseen thing that to date has not entered their minds. The fact that some method of disposing of the spent charges must be found should not be lost to sight. The objections to the suggestion of absorbing the gas by some agent are so great that it may be discarded.

Practically, then, the question of reducing the carbon monoxid now present in automobile exhaust has been brought down to the question of whether some catalytic agent may be employed that will complete the combustion started in the engine cylinder.

The solution of this question rests in the hands of expert chemists and automotive engineers. Some substances are already known that will secure the catalysis of carbon monoxid to carbon dioxid, but the feasibility of their use has not been fully ascertained.

Spongy platinum at a dull heat in the presence of air will rapidly catalyze carbon monoxid. Platinum is a rare element that is already beyond the purchasing power of most people and its general use in automobile exhaust pipes is therefore impracticable.

A mixture of carbon monoxid and hydrogen when passed over finely divided nickel forms methane and carbon dioxid, the nickel not being affected. Such means of ridding the exhaust of CO is, however, barely worth consideration. In the first place, methane is as highly objectionable as carbon monoxid from many standpoints; also to require every automobile to be provided with a cylinder of hydrogen would be ridiculous.

A heated palladium wire will readily convert carbon monoxid and oxygen (air) into carbon dioxid at 300°. Palladium is also expensive and "something just as good" will have to be sought. Gold and silver wires have already been tried, but they fuse without causing the gases to unite and hence cannot be employed.

So far efforts of chemists and automotive engineers to find a catalyzer suitable for converting the carbon monoxid in automobile exhaust gases into carbon dioxid have failed owing largely either to the great cost of the catalytic agent, or to the fact that the small amount of tar in the exhaust is deposited on the catalyzer rendering it ineffective. This line of search, however, has not been exhausted, and it is to be hoped that further studies will develop a satisfactory catalytic agent that will obviate the difficulties now encountered.

XII

Summary

1. In spite of the great amount of study given to carbon monoxid and its effects upon life, there is no agreement among investigators as to the fundamental nature of the problem. One group maintains that the poisonous manifestations of the gas are due solely to oxygen deprivation caused by the affinity of CO for hemoglobin, while another holds that the gas has a specific toxic action on the nerve tissues and cells. Some claim that the gas is promptly dissociated or thrown off by the hemoglobin as soon as the individual breathes pure air; others feel that the combination of carbon monoxid and hemoglobin is a stable compound that is never broken down and is not discharged until the blood corpuscle meets its death. Whether CO poisoning is cumulative in its effects is a matter of question. The weight of present day opinion is in favor of the point of view that the poisonous manifestations of the carbon monoxid are due solely to anoxemia.

2. The effects upon the human system of frequent exposure to very low concentrations of carbon monoxid in the inspired air need detailed study. The many now disputed questions as to the action of the gas require settling, particularly in relation to the pollution of the air by the automobile exhaust gas.

3. The studies for the Public Health Committee of the New York Academy of Medicine by Professor Yandell Henderson

show that under certain atmospheric conditions, when little breeze is stirring and traffic is heavy, the carbon monoxid content of the street air in New York City reaches a point where prolonged and continuous exposure to it may have deleterious effects.

4. The present percentage (from 7 to 14 per cent.) of carbon monoxid in automobile exhaust gases is unnecessarily high. A high content of this gas represents a heavy sacrifice of miles per gallon for the sake of power and ease in starting a cold motor. Ample power may be had from any machine from a CO content of but three per cent. by volume of the exhaust gases, and the present average content of over seven per cent. is wasteful.

5. Motor fuels have been developed that are said to give nearly double the mileage per gallon. Even though the same volume of carbon monoxid may be given off from a unit volume of such gasoline, its effect upon the street air will be much reduced, owing to its being exhausted over a greater distance.

6. There is, of course, the possibility that some catalytic agent may be developed which will cause the carbon monoxid of the automobile exhaust to be converted in the presence of oxygen into carbon dioxid, a relatively harmless gas. There is, likewise, a probability of utilization of fuel other than gasoline for internal combustion engines.

7. There is need of effective safeguarding of the health of those exposed to the dangers of carbon monoxid in industry and elsewhere by state and municipal authorities.

The Sub-Committee

JAMES B. CLEMENS, M.D., Chairman
W. GILMAN THOMPSON, M.D.

LIBRARY NOTES

PARIS THESES

The Paris Theses for the school years 1924 and 1925 are now in the library and are available for reference.

TWO VALUABLE ACCESSIONS

Through the generosity of a group of the Fellows of the Academy we have recently been enabled to purchase a copy of the first

edition of one of the greatest medical books, that is, "De medicina libri octo," by Aurelius Cornelius Celsus, Florence, printed by Nicolaus Laurentii, 1478. This particular copy is not absolutely perfect, but we are lucky to find one at all. Already, a Fellow of the Academy has offered to take the book over from us should we become the possessors of a better one.

We know little of Celsus except that he lived in the Augustan age and in all likelihood was not a medical man. "He probably intended his treatises on agriculture, medicine, war and rhetoric to form a compendium of all knowledge requisite for a wealthy citizen, who had a farm and slaves to superintend, and might hold a public office" (Withington). The manuscript of Celsus was not brought to light until the fifteenth century.

Celsus gives a good outline of the history of medicine up to his time, mentions many physicians whose writings are now lost and tells us the state of Roman medicine of his period. Garrison praises especially the descriptions in Book II of abnormalities of the urine, symptoms of stone in the bladder, prodromata of insanity, and symptoms of the last stages of consumption.

All the Fellows of the Academy, we feel sure, are grateful for the present of this incunabulum.

A bibliographer has been described as "one who copies other peoples' mistakes and adds to them himself"! This is a rather harsh description as can be readily proved by a look at John Ferguson's "Bibliotheca Chemica, a Catalogue of the Alchemical, Chemical and Pharmaceutical Books in the Collection of the late James Young of Kelly and Durris, Esq., LL.D., F.R.S., F.R.S.E.," Glasgow, James Maclehose and Sons, 2 vols., 1906. A copy of this book has recently been very generously donated to the Academy by the "trustees and family of the late Dr. James Young of Kelly" and it stands as a shining example of what a bio-bibliography, or catalogue raisonné, should be. The choice collection of about 1,400 books listed alphabetically under author was made by Dr. Young (1811–1883), who was a native of Glasgow, studied chemistry under the famous Graham and later "came to be the originator of the paraffin oil industry in Scotland." Young, before he died, established a chair of technical chemistry in Anderson's College and bequeathed this library to this chair.

Professor Ferguson, who died a few years ago, was Regius Professor of Chemistry in the University of Glasgow. He has dealt fully with each author and each work and details of the life of the man and the lives of his books are given in notes. These volumes are tools which the medical bibliographer should be proud to possess.

The volumes were printed for private distribution and in paper and typography are as handsome as well could be. Each volume contains as frontispiece a photogravure of James Young.

A. M.

RECENT ACCESSIONS TO THE LIBRARY

Bailey, P., & Cushing, H. A classification of the tumors of the glioma group on a histogenic basis.
Phila. Lippincott. 1926. 175 p.

Bauer, L. H. Aviation medicine.
Balt. Williams. 1926. 241 p.

Bergamini, M. La chimica del sistema nervoso centrale durante lo sviluppo del bambino normale e patologico.
Milano. Soc. ist. edit. sci. 1926. 238 p.

Blacker, C. P. Birth control and the state.
Lond. Kegan Paul. 1926. 95 p.

Borst, M. Pathologische Histologie. 2. Aufl.
Leip. Vogel. 1926. 435 p.

Bousfield, P. Pleasure and pain.
Lond. Kegan Paul. . . . 1926. 114 p.

Buckley, J. P. Modern dental materia medica, pharmacology and therapeutics. 5. ed.
Phila. Blakiston. 1924. 586 p.

Campbell, D. Arabian medicine. 2 vols.
Lond. Kegan Paul. 1926.

Chiarugi, G. I gemelli.
Torino. Union tip. Torinese, 1926. 100 p.

Cieszynski, A. Zahnärztliche Röntgenologie. 2. Aufl.
Leip. Vogel. 1926. 448 p.

Cole, F. J. The history of protozoology.
Lond. Univ. of Lond. pr. 1926. 64 p.

Conn, H. J. Biological stains.
Geneva, N. Y. Com. on stand. of biol. stains. 1925. 151 p.

Crichton-Browne, Sir J. Burns, [Robert]; from a new point of view.
Lond. Hodder. [1926.] 92 p.

Cushny, A. R. The secretion of the urine. 2. ed.
Lond. Longmans. 1926. 288 p.

Damade, R. Études sur le tubage duodénal.
Paris. Doin. 1926. 100 p.

Dennett, R. H. Simplified infant feeding. 3. ed.
Phila. Lippincott. 1926. 415 p.

De Vecchis, B. Trattato di odontoiatria e protesi dentaria. Vol. 1.
Napoli. La cuttura stomatologica. 1925.

Edgar, J. C. Edgar's practice of obstetrics. 6. ed.
Phila. Blakiston. 1926. 779 p.

Ellis, H. The world of dreams.
Lond. Constable. 1926. 288 p.

Foote, J. A. Diseases of the new-born.
Phila. Lippincott. 1926. 231 p.

Fowler, Sir J. K. Aix-lex-Bains and Mont Revard.
Lond. Heinemann. 1926. 63 p.

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N. Y. Hoeber. 1926. 58 p.

Goldberg, I. Havelock Ellis.
N. Y. Simon. 1926. 359 p.

Griffith, G. T. Population problems of the age of Malthus.
Cambridge. Univ. pr. 1926. 276 p.

von Gruber, M. Hygiene of sex.
Balt. Williams. 1926. 169 p.

Handbuch der praktischen Therapie. . . . Hrsg. von R. von den Velden und P. Wolff. v. 1.
Leip. Barth. 1926. v. 1 in 2 pts.

Handbuch der Sexualwissenschaften. Hrsg. von A. Moll. 3. Aufl.
Leip. Vogel. 1926. 2 vols.

Harvey, F. Health legislation.
Lond. Lewis. 1926. 207 p.

Hirschman, L. J. Handbook of diseases of the rectum. 4. ed.
St. Louis. Mosby. 1926. 403 p.

v. Hoesslin, H. Das Sputum. 2. Aufl.
Berlin. Springer. 1926. 485 p.

Hogben, L. T. Comparative physiology.
Lond. Sidgwick. 1926. 219 p.

Holmes, G. W., & Ruggles, H. E. Roentgen interpretation. 3. ed.
Phila. Lea. 1926. 326 p.

Humphris, F. H. Artificial sunlight and its therapeutic uses.
3. ed. Lond. . . . Oxford pr. 1926. 236 p.

Journé. Précis de pathologie médicale. 2. éd.
Paris. Maloine. 1926. 1520 p.

Junius, P., & Kuhnt, H. Die scheibenförmige Entartung der Netzhautmitte.
Berlin. Karger. 1926. 132 p.

Kilduffe, R. A. A manual of clinical laboratory procedure.
St. Louis. Mosby. 1926. 287 p.

Krebskrankheit (Die). Ein zyklus von Vorträgen, hrsg. von der Oester. Gesell. zur Erforschung und Bekämpfung der Krebskrankheiten.
Wien. Springer. 1925. 356 p.

Leim, O. L. Your hair and your health.
N. Y. Greenberg. 1926. 163 p.

Lettieri, R. Anestesia dei nervi periferici.
Milano. Alfieri. 1925. 178 p.

Lian, C., & Finot, A. L'hypertension artérielle. 2. éd.
Paris. Flammarion. 1926. 247 p.

Liébault, G. Notions élémentaires d'oto-rhino-laryngologie à l'usage des praticiens.
Paris. Doin. 1926. 236 p.

Löhe, H. Die Geschlechtskrankheiten.
Berlin. Karger. 1926. 213 p.

Lowsley, O. S., & Kirwin, T. J. A text-book of urology.
Phila. Lea. 1926. 699 p.

Lütkens, U. Aufbau und Funktion der extrahepatischen Gallenwege.
Leip. Vogel. 1926. 205 p.

McDougall, W. Outline of abnormal psychology.
N. Y. Scribner. 1926. 572 p.

Mackenzie, Sir J. The basis of vital activity.
Lond. Faber. 1926. 132 p.

Mackenzie, Sir L. The child at school.
Lond. Faber. 1926. 232 p.

Maclean, H. Modern views on digestion and gastric disease.
Lond. Constable. 1925. 170 p.

Maier, H. W. Der Kokainismus.
Leip. Thieme. 1926. 269 p.

Martinet, A. Diagnostic clinique. 5. éd.
Paris. Masson. 1925. 1041 p.

Mayo, C. H., & Plummer, H. W. The thyroid gland.
St. Louis. Mosby. 1925. 83 p.

Mayr, J. K. Die Erscheinungen an der Haut bei inneren Krankheiten.
Leip. Vogel. 1926. 117 p.

Meyer, H. H., & Gottlieb, R. Experimental pharmacology. 2. ed.
Phila. Lippincott. 1926. 656 p.

Mariani, G. La questione sessuale.
Milano. Soc. ist. ed. sci. 1926. 457 p.

Moore, D. T. V. Dynamic psychology. 2. ed.
Phila. Lippincott. 1926. 444 p.

Ogden, C. K. The meaning of psychology.
N. Y. Harper. 1926. 326 p.

Orr, T. G. Modern methods of amputation.
St. Louis. Mosby. 1926. 117 p.

Parker, E. M., & Breckinridge, S. D. Surgical and gynaecological nursing.
Phila. Lippincott. 1925. 429 p.

Parrisius, W. Röntgenbehandlung innerer Krankheiten.
Leip. Hirzel. 1926. 227 p.

Pauchet, V., & Gaehlinger, H. La constipation.
Paris. Doin. 1926. 223 p.

Petit, C. Précis d'électrocardiographie.
Paris. Baillière. 1926. 157 p.

Population problems in the United States and Canada. Ed. by L. I. Dublin.
Boston. Houghton. 1926. 318 p.

Pruette, L. G. Stanley Hall.
N. Y. Appleton. 1926. 266 p.

Reilly, J. [et al.]. Physico-chemical methods.
Lond. Methuen. 1926. 735 p.

Ribolla, R. Medicina tropicale e igiene marinara.
Roma. Pozzi. 1926. 453 p.

Sattler, H. Die bösartigen Geschwülste des Auges
Leip. Hirzel. 1926. 361 p.

Schaefer, M. Das Staatsexamen für männliche und weibliche Krankenpflegepersonen.
Leip. Barth. 1926. 240 p.

Schröder, R. Lehrbuch der Gynäkologie. 2. Aufl.
Leip. Vogel. 1926. 725 p.

Secher, K. Treatment of tuberculosis with sanocrysin and serum.
Copenhagen. Levin. 1926. 256 p.

Simpson, C. O. The technic of oral radiography.
St. Louis. Mosby. 1926. 207 p.

Strümpell, A. Lehrbuch der speziellen Pathologie und Therapie inneren Krankheiten. 25. Aufl.
Leip. Vogel. 1926. 2 vols.

Sutton, R. L. Diseases of the skin. 6. ed.
St. Louis. Mosby. 1926. 1303 p.

Thornton, J. D. Human physiology. 3. ed.
Lond. Longmans. 1926. 463 p.

Transactions of the American climatological and clinical association. 1925.

Transactions of the Luzerne County Medical Society. 1924–1925.

Voronoff, S. Studio clinico di endocrinologia.
Milano. Soc. ist. ed. sci. 1926. 167 p.

Weber, A. Die Elektrokardiographie.
Berlin. Springer. 1926. 208 p.

Weinberger, B. W. Orthodontics; an historical review.
St. Louis. Mosby. 1926. 2 vols.

Würtzen, C. H. Recherches sur les effets de la sanochrysine.
Copenhague. Levin. 1926. 224 p.

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John Howland, M.D., B.A., Johns Hopkins Hospital, Baltimore, Md., graduated in medicine from Cornell University, 1899;

elected a Fellow of the Academy March 3, 1904; died June 20, 1926. Dr. Howland was a Fellow of the American Medical Association, and a member of the Pediatric Society.

Bernard S. Talmey, M.D., 155 West 118th Street, New York, N. Y., graduated in medicine from the University of Münich, Germany, 1892; elected a Fellow of the Academy May 3, 1906; died June 30, 1926.

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